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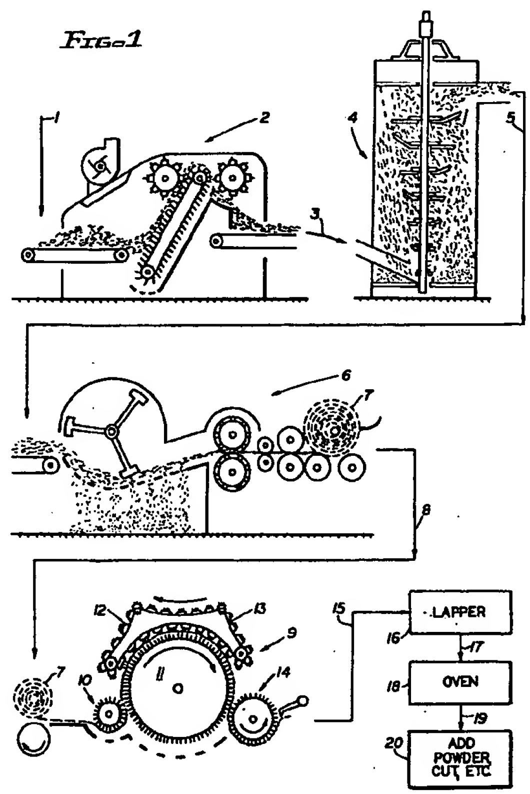
(54) **Method for making insulation.**

(57) A method and apparatus for producing a low density thermal insulation batt. The batt includes binder fibers which have been softened to adhere to and interconnect insulative fibers in the batt, and also includes short stilt fibers which interconnect and space apart the insulative fibers to define interstitial air pockets intermediate the insulative fibers.

FIG. 1



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This invention relates to insulation and methods for producing the same.

More particularly, the invention relates to a method and apparatus for producing a low density thermal insulation batt which includes insulative fibers having a low denier and which includes binder fibers which have been softened to adhere to and interconnect insulative fibers in the batt.

In another respect, the invention relates to a method and apparatus for producing a thermal insulation batt of insulative fibers which also includes short stilt fibers which interconnect and space apart the insulative fibers to define interstitial air pockets intermediate the insulative fibers.

U. S. Patent No. 4,678,822 to Lewellin describes a method for producing a bonded fiber insulation batt. In the Lewellin method, a carding machine is utilized to form a web. The web passes through a lapping machine which folds the web onto itself to form a batt. While the web is being lapped into batt form, a RHOPLEX resin emulsion is sprayed onto the web. The batt formed by the lapping machine is heated to dry the resin emulsion. The resin sprayed on the batt is important, because Lewellin relies on the resin to ensure the batt retains its bulk and structural integrity. In his patent, Lewellin notes that two advantages of an insulation batt produced by his method are that the batt does not present the health hazard of fiberglass batts and that the batt occupies a lesser space than fiberglass batts. Finally, Lewellin notes that the insulative value of his batt is equal to that of a fiberglass batt. The density of the Lewellin batt is about 1.5 lbs/ft. The resin increases the density of the Lewellin batt.

While the insulation batt described in the Lewellin patent has advantages over conventional fiberglass batts, Lewellin does not address the problem of producing a low density insulation batt which does not require the use of a resin spray to bond together insulative fibers in the batt. Reducing the density of an insulation batt and eliminating the use of a resin spray significantly reduces the cost of producing and utilizing the batt. A low density insulation batt requires less material in manufacture and costs less to transport.

Accordingly, it would be highly desirable to provide an improved low density insulation batt which would not require the use of conventional spray resins to bond together insulative fibers comprising the batt.

Therefore, it is a principal object of the invention to provide an improved method and apparatus for producing insulation and to provide an improved insulation batt.

A further object of the invention is to provide an improved insulation batt which has a significantly lower density than conventional batts.

Another object of the instant invention is to provide an improved method for producing an insulative batt, the method not requiring the utilization of spray apparatus to apply a resin to the batt to bind together insulative fibers comprising the batt.

Still another object of the invention is to provide an improved insulation composition which utilizes relatively short stilt fibers to interconnect and space apart insulative fibers to maintain interstitial air pockets thereinbetween.

Yet still a further object of the invention is to provide an improved insulation composition which includes binder fibers which have a softening temperature less than the melting temperature of the insulative fibers comprising the majority of the batt, the insulation batt being heated to a temperature greater than the softening temperature and less than the melting temperature to soften the binder fibers and cause them to adhere to and interconnect insulative fibers.

These and other, further and more specific objects and advantages of the invention will be apparent to those skilled in the art from the following detailed description thereof, taken in conjunction with the drawings, in which;

Fig. 1 is a flow diagram depicting a method of manufacture of an insulation batt in accordance with the principles of the invention;

Fig. 2 is a flow diagram depicting a method of manufacture of an insulation batt in accordance with an alternate embodiment of the invention; and,

Figs. 3 and 4 illustrate still another alternate embodiment of the invention.

Briefly, in accordance with my invention, I provide a method for forming a thermal insulation batt. The method includes the steps of blending at a first selected temperature binder fibers with insulative fibers, the binder fibers having a bonding temperature at which the binder fibers soften and adhere to the insulative fibers, the insulative fibers being selected from the group consisting of synthetic and natural fibers and having a melting temperature greater than the bonding temperature and at which at least certain of the insulative fibers melt, the bonding temperature being greater than 130°F and greater than the first selected blending temperature; processing the blended fibers at a second selected temperature less than the bonding temperature to form a batt; heating the batt to a temperature equal to or greater than the bonding temperature and less than the melting temperature to cause the binder fibers to soften and adhere to the insulative fibers to connect insulative fibers to one another; and, cooling the batt to harden the softened binder fibers.

In another embodiment of my invention, I pro-

vide an improved method for forming a thermal insulation batt. The method includes the steps of processing at a first selected temperature insulative fibers to form a web having a selected thickness, the insulative fibers being selected from the group consisting of synthetic and natural fibers and having a melting temperature at which at least certain of the insulative fibers melt, the melting temperature being greater than the first selected temperature; transporting at a second selected temperature the web to a lapping machine to be lapped into a batt having a thickness greater than the web; lapping at a third selected temperature the web with the lapping machine to form a batt having a greater thickness than the web; transporting at a fourth selected temperature the batt from the lapping machine to apparatus for heating the batt to a temperature greater than or equal to a selected softening temperature and less than said melting temperature; applying binder fibers to said web during at least one of the process steps selected from the group consisting of steps (b), (c), and (d), the binder fibers softening and adhering to the insulative fibers at the selected softening temperature, the softening temperature being greater than 130 °F, less than the melting temperature, and greater than the selected temperature for the one(s) of the steps (b), (c), and (d) during which the binder fibers are applied to the web at the selected temperature for the one(s) of the steps (b), (c), and (d); heating the batt with the heating apparatus to a temperature equal to or greater than the selected softening temperature and less than the melting temperature to cause the binder fibers to soften and adhere to the insulative fibers to connect certain of the insulative fibers to one another; and, cooling the batt to harden the softened binder fibers.

Turning now to the drawings, which depict the presently preferred embodiments of the invention for the purpose of illustrating the practice thereof and not by way of limitation of the scope of the invention, a method for producing an insulative batt is illustrated in Fig. 1 in which bales of cotton 1 or another insulative or "bulk" fiber are first loosened up and separated into individual fibers or small groups of fibers by the hopper bale-breaker 2. Other hopper bale-breakers 2 are utilized to "open" binder fibers, stilt fibers, or other types of fibers to be blended with or added to fibers produced by bale-breaker 2. Fibers from hopper bale-breaker 2 are directed into blender-opener 4. Binder fibers, stilt fibers or other types of insulative fibers can be added to blender-opener 4 in any desired proportion with insulative fibers 3 from hopper-breaker 2. Fibers from blender-opener 4 are transported 5 to the picker or scratcher 6. Picker 6 forms the loose fibers into a sheet (the lap) which is wound into a roll 7. Roll 7 is transported 8 to a revolving flat card machine 9 and fed into machine 9. Card machine 9 includes a taker-in roller or licker-in 10 provided with teeth which tear away small bunches of fiber from the lap. Main cylinder 11 is provided with teeth which strip small bunches of fiber from the licker-in. Narrow bars or flats 12 are carried by an endless belt 13 and are provided with teeth which exercise a combing action and remove impurities. The web from main cylinder 11 travels around doffer 14 and is directed or transported 15 to a lapper 16. The lapper folds the web 15 upon itself to produce a batt of desired thickness. Lapper 16 is preferably a cross-lapper, but can be any conventional lapper machine. Similarly, card machine 9, picker 6, blender-opener 4 and bale-breaker 2 can be replaced with any conventional apparatus performing similar functions with respect to the insulative, stilt, and binder fibers used on the practice of the method of the invention. Batt produced by the lapper 16 is transported 17 to a bonding oven 18 which heats the batt to a temperature sufficient to soften binder fibers contained in the batt. When the binder fibers soften, they adhere to insulative fibers and bind the insulative fibers to one another. The binder fibers can be intermixed with insulative fibers in blender-opener 4 or added to the web during its transport 15 to lapper 16, during lapping 16, or during transport 17 of the lapped web to oven 18. Heat treated batt from oven 18 is cooled and transported 19 to additional processing stations 20. Stations 20 can add fire retardant to the batt in the form of a spray or powder. Common fire retardation compositions include borates, aluminum hydrate, halogenated hydrocarbons, and decabromo diphensyl dether. Chemical preservatives can be added to the batt to resist mildew and attack by insects. If desired, such fire retardants and chemical preservatives can be added to the web at any convenient processing point before or after the web is produced by card machine 9.

Another procedure performed by processing stations 20 is cutting the batt. The batt can be cut into short segments, balls, and any other desired shape and dimension.

The insulative fiber(s) added to blender-opener 4 in Fig. 1 can be selected from natural fibers like cotton, wool, flax, jute, mohair, silk, ramie, hemp and asbestos or from synthetic fibers like rayon, acetate, nylon, polyester, polyenes, acrylics, vinyons, kevlar or other monoacrylic, acrylic, or polyamide fibers. The proportion of an insulative fiber added to the blender-opener 4 can vary as desired and typically is in the range of 0 to 95% by weight. As earlier noted, a binder fiber is added to the insulative fibers. Binder fibers are added to blender-opener 4 in the proportion in the range of

two to eighty percent by weight of the insulative or bulk fiber. The binder fiber has a softening temperature which is less than the melting temperature of any of the insulative fibers added to blender-opener 4. Accordingly, when a batt from lapper 16 passes through oven 18, oven 18 is heated to a temperature equal to or greater than the softening temperature of the binder fiber and less than the melting temperature of any of the insulative or bulk fibers. Oven 18 thus causes the binder fibers to soften and adhere to the insulative fibers and bond or interconnect insulative fibers to one another. As used herein, the term "soften" when applied to binder fibers means that the binder fiber begins to lose its hardness and/or melts such that the binder fiber can adhere to and interconnect insulative fibers after the binder fibers are heated to a selected temperature and then cooled to a normal room temperature of 78° F. Some binder fibers become "sticky" and adhere to an insulative fiber before the binder fiber melts. Other binder fibers have to melt before they will adhere to insulative fibers. A melted binder fiber and a softened "sticky" binder fiber each comprise a "softened" binder fiber. The presently preferred binder fiber is a polyester fiber. Any other desired synthetic or natural fiber can be utilized as a binder fiber.

The use of polyester fibers is known in connection with the production of medical blankets and feminine hygiene pads. In such uses, polyester fibers form a water resistent layer. For example, on medical blankets of the type utilized in operating rooms, polyester fibers form the backing on the blanket. On KOTEX feminine hygiene napkins, a water resistant sleeve made from polyester surrounds the inner absorbent part of the napkin. These uses bear no relation to the production of thermal insulation and do not suggest the function of polyester binder fibers in the method of the invention.

The binder fibers can be added to lap 7 or can be added to the web at any point after the web is produced by card machine 9 and prior to heating of the batt in oven 18. The melting temperature of the binder fibers can vary as desired as long as the melting temperature is greater than the temperature(s) at which the binder fibers are processed by machines 4, 6, 9, and 16 in the method of the invention up until the batt is heated in oven 18, provided that the melting temperature of the insulative fibers is greater than the softening temperature of the binder fibers, and provided that the softening temperature is at least 130° F. Binder fibers with softening temperatures less than 130° F are inconvenient because the binder material may soften or melt when maintained in an non-air conditioned storage shed in the summer or in the enclosed non-air conditioned bed of a vehicle. The preferred melting temperature of the binder fibers is presently in the range of 180° F to 450° F. The binder fibers can take the form of actual fiber or of powder produced from fibers or from the material used to make fibers. Adding binder fibers in powder form, particularly in blender-opener 4, can be advantageous. In contrast, the insulative fibers comprising a large portion of the batt are in true fiber form. Otherwise, the insulative fibers could not be processed by bale-breaker 2, blender-opener 4, picker 6, and card machine 9. The binder fibers have a length in the range of 0.5 to 2.0 inches, with a length of 1.5 inches being preferred. Eastman Kodak 410 binder fiber is presently a preferred binder fiber in the practice of the invention.

The insulative fiber(s) 1 used in the practice of the invention are 0.5 inches or longer, and are typically in the range of 0.5 inch to 1.5 inches long. The insulative fiber can have a denier in excess of 3.0, but a denier of 3.0 or less is preferred because the insulative batt produced is unusually light. When cotton is utilized, a denier in the range of 2.4 to 3.0 is preferred. The web produced by the car machine 9 has a preferred thickness in the range of 1/16 inch to 3/16 inch, even though a card machine can produce much thinner or thicker webs. By way of example, when a Hollingsworth 2.5-Meter-working-width MASTERCARD card machine is utilized, the licker-in roll 10 uses wire in the range of 40 to 50 teeth per square inch, preferably 50 teeth per square inch, and a working angle of 15° to 25°, preferably 20°; the main cylinder 11 uses wire in the range of 300 to 700 teeth per square inch, preferably 500 teeth per square inch, and a working range in the range of 17° to 27°, preferably 22°; and, the doffer 14 uses wire in the range of 150 to 250 teeth per square inch, preferably 250 teeth per square inch, and a working angle in the range of 17° to 27°, preferably 22°. If desired, a plurality of card machines 9 can be utilized to produce web fed to lapper 16. An air lay machine, garnet or comparable web weaving machine can be utilized in place of card machine 9. The air lay machine produces a heavier non-uniform web. A garnet machine would produce web having larger air pockets than the web produced by card machine 9. The card machine is preferred in the practice of the invention because it discretely separates fibers and produces a relatively uniform fine kleenex-like spider web principally comprised of parallel, elongate strands of thread. These parallel strands comprise approximately 80 to 85% by weight, or more, of the web, while the remaining weight of the web consists of strands which are at an angle to and interconnect the parallel, elongate strands. Accordingly, when web produced by a card machine 9 is cross lapped 16, each succeeding layer of web in the batt has a longitudinal axis

which is parallel to the parallel, elongate strands comprising the majority of the web layer and which is rotated 20° to 60°, pref rably 30°, from the longitudinal axis of the preceding web layer in the batt.

When web produced by card machine 9 is being lapped by lapper 16, stilt fibers can be spread on a lapped layer of web just prior to the time that lapper 16 covers the first lapped layer of web with another web layer. These stilt fibers are 1/16 inch to 3/8 inch long, preferably 1/8 inch to 1/4 inch long. The stilt fibers function to spread apart and maintain a space between adjacent lapped web layers comprising the batt. When the batt is heated in oven 18, softened binder fibers adhere to and interconnect stilt fibers and insulative fibers. When the stilt fibers are applied to the web, additional binder fibers can be applied with the stilt fibers to facilitate the bonding of stilt fibers to insulative fibers. Stilt fibers are preferably applied to horizontally disposed layers of web during lapping of the web by lapper 16 because the stilt fibers tend to "ride" on top of lower layer of web to separate the lower layer from the web layer adjacent and just above the lower layer. When the batt is heated by oven 18, the stilt layers are bonded to insulative fibers and the stilt fibers intermediate two adjacent web layers maintain a spacing in the range of 1/32 inch to 1/8 inch, typically 1/16 inch. The spacing between web layers produced by the stilt fibers significantly increases the insulative value and decreases the weight of insulation produced in accordance with the invention. Stilt fibers can, if desired, be blended with longer insulative fibers in blender-opener 4 or can be spread on or applied to the web at any point in the process of the invention after the web is produced by and leaves the card machine 9. KODAFIL 435 is a synthetic fiber which can be utilized as a stilt fiber, as are cotton fibers having a length in the range of 1/8 inch to 3/8 inch. Stilt fibers, like insulative fibers, have a melting point or temperature which is greater than the softening temperature of binder fibers used in the insulation batt of the invention.

Another embodiment of the invention is illustrated in Fig. 2 in which bales of cotton 1 or another insulative or "bulk" fibers are loosed up and separated into individual fibers or small groups of fibers by the hopper bale-breaker 2. Other hopper bale-breakers 2 can be utilized to "open" binder fibers, stilt fibers, or other types of fibers to be blended with or added to fibers produced by bale-breaker 2. Fibers from hopper bale-breaker 2 are directed 3 into the blender-opener 4. Binder fibers, stilt fibers, or other types of insulative fibers can be added to blender-opener 4 in any desired proportion with insulative fibers 3 from hopper-breaker 2. Fibers from the blender-opener 4 are transported 5 to the dispensing funnel 23 of the opener 21. Fibers 36 falling into mixing chamber 33 of op ner 21 through funnel 23 are intermixed, torn and separated by turbulence 37 caused by at least one incoming stream of air 22. Air stream 22 can also open fibers by causing the fibers to impact a beater or grate of the type shown in opener 4 or to impact some other structural member. The air introduced into chamber 33 by stream 22 passes into chamber 34 in the manner indicated by arrow 24. The air stream 24 traveling into chamber 34 is bifurcated into a stream 26 passing out through vent 25 and a stream 28 passing out through vent 38. Pivoting door 37 covers vent 38. Intermixed fibers 36 carried into chamber 34 by air stream 24 settle or are carried into rectangular steel plate 31. Vibrator means 32 vibrate plate 31 to settle and compact the fibers 36 which gather on plate 31. When a sufficient weight of fibers has gathered on plate 31, conveyor 30 causes the batt 29 formed by the compacted fibers to travel outwardly in the direction of arrow 40 through vent 38. The pressure of air stream 28 against fibers 36 on plate 31 also facilitates the compacting of the fibers which gather on plate 31. The compacting pressure of air stream 28 may obviate the need for using vibrator means 32. Other compacting means can be used separately from or in combination with air stream 28 and means 32 to compact and amalgamate fibers. Plate 31 rests on scales or weight means which determines the weight of fibers 36 collected on plate 31. When the weight means determines that the weight has reached a selected value, conveyor 30 is operated to transport the batt 29 formed on plate 31 out from chamber 34 in the direction of arrow A. If desired, conveyor 30 can gradually continually transport a single elongate batt 29 from opener 21 as the batt is produced by opener 21. The batt 29 is moved by conveyor 30 into oven 18 for heat treatment. Heat treated batt from oven 18 is cooled and transported to additional processing stations 20. Stations 20 can add fire retardant to the batt in the form of a spray or powder, or chemical preservatives can be added to the batt to resist mildew and attack by insects. Another procedure performed by processing stations 20 is cutting the batt. The batt can be cut into short segments, balls, and any other desired shape and dimension.

Conventional methods of producing an insulative batt utilize a carding machine 9. The process of Fig. 2 eliminates the necessity of utilizing a carding machine and increases the production rate by about five times over conventional insulative batt production methods which incorporate a carding machine. A principal feature of the method of Fig. 2 is the utilization of one or more "openers" to form an insulative batt which is fed directly into oven 18. As used herein, an opener is a machine

which utilizes air turbulence and possibly beaters, grates or other means to intermix and separate fibers and which can also include means for collecting and at least partially compacting the intermixed randomly oriented fibers to form a loose batt. Opener 21 and opener 4 are examples of openers.

The same types, quantities, and proportions of insulative fibers, binder fibers, and stilt fibers utilized in the method of Fig. 1 can be utilized in the method of Fig. 2. The weight percent of stilt fibers in a batt produced in accordance with the method of Fig. 2 is preferably in the range of 5% to 20%.

A three and a half inches thick insulative batt produced in accordance with the method of Fig. 2 presently has a weight of about two to two and a half ounces per square foot and an R value of 11. The thickness of batt 29 ordinarily is in the range of about one to eight inches.

Opener 21 can comprise the VIBRACHUTE CARD FEEDER produced by John D. Hollingsworth On Wheels, Inc. of Greenville, SC 29602-0516, USA.

The following examples are presented, not by way of limitation of the scope of the invention, but to illustrate to those skilled in the art the practice of various of the presently preferred embodiments of the invention and to distinguish the invention from the prior art.

EXAMPLE 1

Cotton Fibers having a length of 7/8 inch are selected as insulative fibers. Cotton gin moats and linters each having a length in the range of 1/8 inch to 1/4 inch are selected as stilt fibers. E. I. du Pont Dacron D-262 polyester fibers are selected as binder fibers. The insulative fibers and stilt fibers have a denier of 2.8. The polyester fibers have a denier of 1.8, an elongate percent of 200, a length of 1.5 inches, a melting point of 142°C (softening at 78°C) and a bonding temperature of 155°C (surface) with respect to cotton, i.e., the Dacron D-262 polyester bonds to cotton fibers when heated to 155°C. The melting point of the insulative fibers exceeds 160°C.

A batt is formed using the method of Fig. 1. The insulative fibers, stilt fibers, and binder fibers are blended together in a blender-opener 4 and processed with a picker 6 and card machine 9 to form a web which is transported 15 to a lapper 16. The insulative fibers comprise 60% by weight of the blended mixture; the cotton moats 20% by weight of the blended mixture; and, the binder particles 20% by weight of the blended mixture. The batt produced by lapper 16 is transported 17 to oven 18. The bat is heated in oven 18 to a temperature equal to or in excess of 155°C to soften the polyester binder fibers and bond them to the insulative and stilt fibers. After being removed from oven 18 and cooled, the batt is cut 20 into six foot long sections and packaged. The batt is 2.9 inches thick and one foot wide and has a density of 8 ounces per cubic foot. The thickness, length, and width of the batt can be varied as desired. The insulation value or "R value" of the batt is R-11. The "R-value" of insulation indicates the time in hours required for one BTU to be transmitted through a one square foot area of the insulation when there is a difference of one degree Fahrenheit between the two opposing outer surfaces of the insulation.

The 2.9 inch thick R-11 batt produced in this Example is lighter than a comparably sized fiberglass batt and has a greater R value than the fiberglass batt.

EXAMPLE 2

Cotton fibers having a length of one inch, wool fibers having a length of 7/8 inch, and rayon fibers having a length of 1.5 inches are selected as insulative fibers. Cotton gin moats and linters and acrylic fibers each having a length in the range of 1/8 inch to 1/4 inch are selected as stilt fibers. E. I. du Pont D-262 polyester fibers are selected as binder fibers. The insulative fibers and stilt fibers have a denier of 2.6. The polyester fibers have a denier of 2.2, an elongate percent of 200, a length of one inch, a melting point of 142°C (softening at 78°C) and a bonding temperature of 155°C (surface) with respect to cotton and 120°C with respect to acrylic fibers. The melting point of the insulative fibers exceeds 160°C.

A batt is formed using the method of Fig. 1. The insulative fibers and binder fibers are blended together in a blender-opener 4 and processed with a picker 6 and card machine 9 to form a web which is transported 15 to lapper 16. The stilt fibers are separately blended together in a blender-opener 4 with binder fibers to form a stilt-binder fiber mixture. The insulative fibers comprise 70% by weight of the web produced by the card machine 9, while the binder fibers comprise 30% by weight of the web produced by card machine 9. The stilt fibers comprise 60% by weight of the stilt-binder fiber mixture, while the binder fibers comprise 40% by weight of the stilt-binder fiber mixture. While the web produced by card machin 9 is b ing lapp d, a 1/8 inch to 1/4 inch layer of the stilt-binder fiber mixture is spread on the upper horizontal surface of each layer of the web deposited by the lapper 16. The layer of the stilt-binder fiber mixture is deposited before the lapper 16 lays down on the upper horizontal surface of a deposited or "laid" web layer the next subsequent layer. Accordingly,

after lapper 16 has produced a batt, each adjacent pair of horizontally oriented web layers comprising the batt will sandwich a stilt-binder fiber layer which is 1/8 inch to 1/4 inch thick.

The batt produced by lapper 16 is heated in oven 18 to a temperature of 120°C so the binder fibers soften and bond to both the cotton and acrylic insulative fibers. After the binder fibers have bonded to the insulative fibers, the batt is removed from the oven and cooled. At processing stations 20 the batt is cut into lengths 50 feet long and rolled and packaged. The batt is 2.9 inches thick, 1 foot wide and has an R value of about 12. The thickness, width and length of the batt can be varied as desired. The stilt fibers maintain a spacing of about 1/8 inch between adjacent web layers in the batt. The stilt-binder fiber mixture added to the batt comprises about 15% by weight of the finished batt, with the insulative-binder fiber mixture of the web comprising the remaining 85% by weight of the batt. The density of the batt is 7 ounces per cubic foot.

The stilt fibers can comprise 1% to 50% by weight of the insulation batt produced by the method of the invention. Preferably, the stilt particles comprise 5% to 20% by weight of the batt.

When the cotton batt of Example 2 is five inches thick, the R value of the batt is about 19. A fiberglass batt must be six inches thick to achieve an R value of 19. When the cotton batt of Example 2 is 7.9 inches thick, it has an R value of 30. When the cotton batt of Example 2 is 2.9 inches thick, the R value of the batt is, as noted, about 11. A fiberglass batt with a thickness of 3.5 inches weighs .23 lbs per square foot of insulation. The 2.9 inch thick cotton insulation of Example 2 weighs about 0.12 lbs per square foot of insulation.

EXAMPLE 3

Cotton fibers having a length of 7/8 inch are selected as insulative fibers. Cotton gin moats and linters each having a length in the range of 1/8 inch to 1/4 inch are selected as stilt fibers. E. I. du Pont Dacron D-262 polyester fibers are selected as binder fibers. The insulative fibers and stilt fibers have a denier of 2.8. The polyester fibers have a denier of 1.8, an elongate percent of 200, a length of 1.5 inches, a melting point of 142°C (softening at 78°C) and a bonding temperature of 155°C (surface) with respect to cotton, i.e., Dacron D-262 polyester bonds to cotton fibers when heated to 155°C. The melting point of the insulative fibers exceeds 160°C.

A batt is formed utilizing apparatus illustrated in Fig. 2. If desired, and appropriate, a hopper bale-breaker 2 can be utilized to open the insulative, stilt or binder fibers. The insulative fibers, stilt fibers, and binder fibers are blended together in a blender-opener 4 and processed with a picker 6 and a card machine 9 to form a web which is transported 15 to a lapper 16. The insulative fibers comprise 55% by weight of the blended mixture; the cotton moats 15% by weight of the blended mixture; and, the binder fibers 30% by weight of the blended fiber mixture. Blended fibers from opener 4 are transported 5 to dispensing funnel 23 of opener 21. Fibers 36 falling through funnel 23 into chamber 33 are intermixed by air stream 22 in the manner earlier described. The air introduced into chamber 33 by stream 22 passes into chamber 34 in the manner indicated by arrow 24. The air stream 24 traveling into chamber 34 is bifurcated into a stream 26 passing out through vent 25 and a stream 28 passing out through vent 28. Intermixed blended fibers 36 carried into chamber 34 by air stream 24 settle or are carried onto rectangular steel plate 31. Vibrator means 32 vibrate plate 31 to settle and compact the fibers 36 which gather on plate 31. When a sufficient weight of fibers has gathered on plate 31, conveyor 30 causes the batt 29 formed by the compacted fibers to travel outwardly in the direction of arrow 40 through vent 38. Conveyor 30 transports 35 batt 29 to oven 18. Oven 18 heats batt 29 to a temperature equal to or in excess of 155°C to soften the polyester fibers and bond them to the insulative and stilt fibers. The temperature in oven 18, while in excess of n155°F, is not sufficient to melt the insulative or stilt fibers. After being removed from the oven 18, the batt 29 is cooled to room temperature. Batt 29 is cut 20 or subjected to other selected processing steps.

In the embodiment of the invention illustrated in Figs. 3 and 4, blended fibers from opener 4 are blown under pressure 5 through conduit 41 into hold box 42. The air pressure utilized is unusually high and is in the range of 3000 to 7000 cubic feet per minute. This high air pressure is important because it tends to compact fibers into fixed hold box or container 42. Air escapes from box 42 through screen 50 in the direction indicated by arrows A in Figs. 3, 4. Wire roller 43 pulls loosely compacted fibers 57 from box 42. Outwardly extending rods 54 on roller 44 pull fibers 57 from wire roller 43 and direct the fibers 57 into fixed chute feed box or container 45. Gravity and rollers 43, 44, 47, 48 move the fibers downwardly through box 45. As fibers 57 move through box 45, spank r plate 46 reciprocates in the directions indicated by arrow C and contacts and packs and compresses fibers 57 against the front wall 56 of feed box 45 to form batt 51. Fluted roller 47 pulls batt 51 from box 45. Fluted roller 48 pulls batt 51 from roller 47 and compresses batt 51 between roller 48 and fixed arcuate support plate 55. Compressed batt 51 trav-

els onto conveyor belt 30 in the direction of arrow 35 to an oven 18 (not shown in Figs. 3 and 4). Conveyor belt 30 transports the batt 51 at a speed of from 20 feet per minute up to 60 feet per minute. In contrast, a conveyor which removes material from a carding machine only travels at about 10 to 15 feet per minute. In Fig. 3, the outwardly extending wires of roller 43, the rods 54 of roller 44, and the outwardly extending flutes on rollers 47 and 48 are omitted for the sake of clarity. Each flute on rollers 47 and 48 comprises an elongate panel which is generally perpendicular to the tangent line at the point the panel is connected to the outer cylindrical surface of the roller and which converges or tapers as the distance from the cylindrical surface of the roller increases. The taper of each flute is evident in Fig. 4. The speed of oscillation of plate 46 is 40 to 80 reciprocations per minute. Rollers 43, 44, 47, 48 move batt 51 at a speed in the range of 20 feet per minute to about 60 feet per minute.

The quantity of fiber fed through conduit 21 into box 42 is sufficient to produce a batt 51 having the desired weight per cubic foot. For example, if the width D of box 45 is ninety inches and the width of the batt 51 produced in and dispensed by box 45 is therefore ninety inches, then about 1124 pounds of fiber per hour is fed through conduit 21 into box 42 to produce a ninety inch wide--four inch thick batt at a rate of twenty feet per minute such that the batt has a weight of about six ounces per cubic foot. The batt 51 produced by the apparatus of Figs. 4 and 5 must weigh at least six ounces per cubic foot of batt, preferably from six to fifteen ounces per cubic foot. When batts of lesser weight per cubic feet are attempted, the fibers tend to fall through box 45 and not be compacted by spanker plate 46. If the batt 51 has a thickness, indicated by arrows T in Fig. 4, that equals four inches, then the batt weighs at least about two ounces per square foot area of four inch batt, i.e., the batt weighs at least six ounces per cubic foot of batt 51.

The thickness T of batt 51 dispensed by box 45 presently can be in the range of from about one-quarter of an inch up to about the width of the box. The width of the box 45 is indicated by arrows F in Fig. 3 and presently is about eight inches. The height of box 45, indicated by arrows E, is presently about eighteen inches.

The great virtue of the apparatus and method of Figs. 4 and 5 is that it can, for example, produce a four inch thick batt weighing about six ounces per cubic foot at a rate of twenty feet per minute or more. In order to produce a similar batt with a carding machine, the output from the carding machine typically is taken at the rate of ten feet per minute and cross lapped four times to produce a batt which has eight layers, has a thickness of four inches, and has a weight of about 3.6 to 4.5 ounces per cubic foot.

As the speed at which batt 51 moves through and is dispensed from box 45 increases, there is a greater likelihood that portions of batt 51 will have "weak" areas which have less density or weight than other portions of batt. This is particularly the case at high rates of production in excess of fifty feet per minute. When batt 51 moves through the machine of Figs. 4 and 5 at such high rates of speed, two or more machines of the type shown in Figs. 4 and 5 can be used simultaneously and the batt output from one machine stacked directly on top of and in register with the batt output from the other machine(s) to form a batt having two or more parallel layers. One batt is not folded on top of the other batt but instead is simply laid on the other batt in a long strip and without being folded. Each layer has approximately the same elongate shape and dimension as the other adjoining layer(s). When the multi-layered batt is heated in oven 18, the binder fibers interconnect the stacked layers. One layer tends to cover and compensate for any areas in the other layer which have a lower-than-desired weight or density compared to other areas in said other layer. Each layer tends not to have "weak" or low weight areas at the same locations as in the adjoining layer. And, if for some reason two adjoining layers have low weight areas at the same locations along the lengths of the layer, one layer is placed on top of the other layer such that areas of low weight in one layer are offset from low weight or low density areas in the other adjoining layer. The stacking of the batts produced by multiple machines of the type shown in Figs. 4 and 5 compensates for structural weakness in individual batts and facilitates the rapid production of thick or high density batts. High density batts can be produced by forming a thick batt and compressing the thick batt with rollers.

Having described my invention in such terms as to enable those skilled in the art to understand and practice it, and having identified the presently preferred embodiments thereof, I Claim:

Claims

1. A method for forming a thermal insulation batt, including the steps of

   (a) blending in open r apparatus at a first selected temperature binder fibers with insulative fibers having a bonding temperature at which said binder fibers soften and adhere to said insulative fibers, said insulative fibers being selected from the group consisting of synthetic and natural fibers and having a melting temperature greater than

said bonding temperature and at which at least certain of said insulative fibers melt, said bonding temperature being greater than said selected blending temperature and said opener apparatus including,

(i) a mixing chamber,

(ii) means for feeding said binder fibers and insulative fibers into said mixing chamber,

(iii) means for directing a stream of air into said mixing chamber to create air turbulence in said chamber which intermixes said binder fibers and insulative fibers,

(iv) an output stream of air carrying said intermixed binder and insulative fibers;

(b) directing said output stream of air into batt forming means to form a batt comprised of said insulative fibers and binder fibers, said batt forming means including

(i) a hold container for receiving said output stream of air and holding said insulative and binder fibers,

(ii) means for transferring insulative and binder fibers from said hold container into a chute feed container,

(iii) means for moving said fibers through said chute feed container,

(iv) means for compressing said fibers together to form a batt while said fibers move through said chute feed container,

(v) means for dispensing said batt from said feed container,

said output stream of air delivering a quantity of fiber to said batt forming means sufficient to produce a batt having a weight in excess of six ounces per cubic foot, said dispensing means dispensing said batt from said feed box at a rate greater than about twenty feet per minute;

(c) heating said dispensed batt to a temperature equal to or greater than said bonding temperature and less than said melting temperature to cause said binder fibers to soften and adhere to said insulative fibers to interconnect said insulative fibers to one another; and,

(d) cooling said batt to harden and soften said binder fibers.

2. The method of Claim 1 wherein stilt fibers are blended in step (a) with said insulative fibers and said binder fibers, said stilt fibers having a second melting temperature, said binder fibers softening and adhering to said insulative and stilt fibers at said selected softening temperature, said softening temperature being less than said first and second melting temperatures.

3. The method of Claim 2 wherein said stilt fibers each have a length in the range of 1/8" to 3/8".

4. The method of Claim 2 or 3 wherein said insulative fibers are cotton.

5. The method of Claim 4 wherein said batt has a thickness greater than about two inches.

6. A method for forming a thermal insulation batt, including the steps of

(a) blending in opener apparatus at a first selected temperature binder fibers with insulative fibers to produce a mixture of said binder and said insulative fibers in random orientation, said insulative fibers having a melting temperature at which at least certain of said insulative fibers melt, said melting temperature being greater than said first selected temperature, said binder fibers having a bonding temperature at which said binder fibers soften and adhere to said insulative fibers, said bonding temperature being greater than 130°F and greater than said selected blending temperature and less than said first selected temperature;

(b) feeding said mixture of fibers into processing means to produce a web;

(c) transporting at a second selected temperature said web to a lapping machine to be lapped into a batt having

(i) a plurality of overlaid folded web layers, and

(ii) a thickness greater than the thickness of said web;

(d) folding at a third selected temperature said web with said lapping machine to form one of said folded web layers;

(e) applying a layer of spacer stilt fibers in random orientation to said one of said folded web layers to ride on top of said one of said folded layers;

(f) folding said web with said lapping machine to form another of said folded web layers extending over and contacting said layer of stilt fibers;

(g) transporting at a fourth selected temperature said batt from said lapping machine to apparatus for heating said batt to said bonding temperature, said bonding temperature being

(i) less than said melting temperature of said stilt fibers, and

(ii) greater than said second, third, and fourth selected temperatures;

(h) heating said batt with said heating apparatus to said bonding temperature to cause said binder fibers to soften and adhere to said insulative fibers and said stilt fibers such that

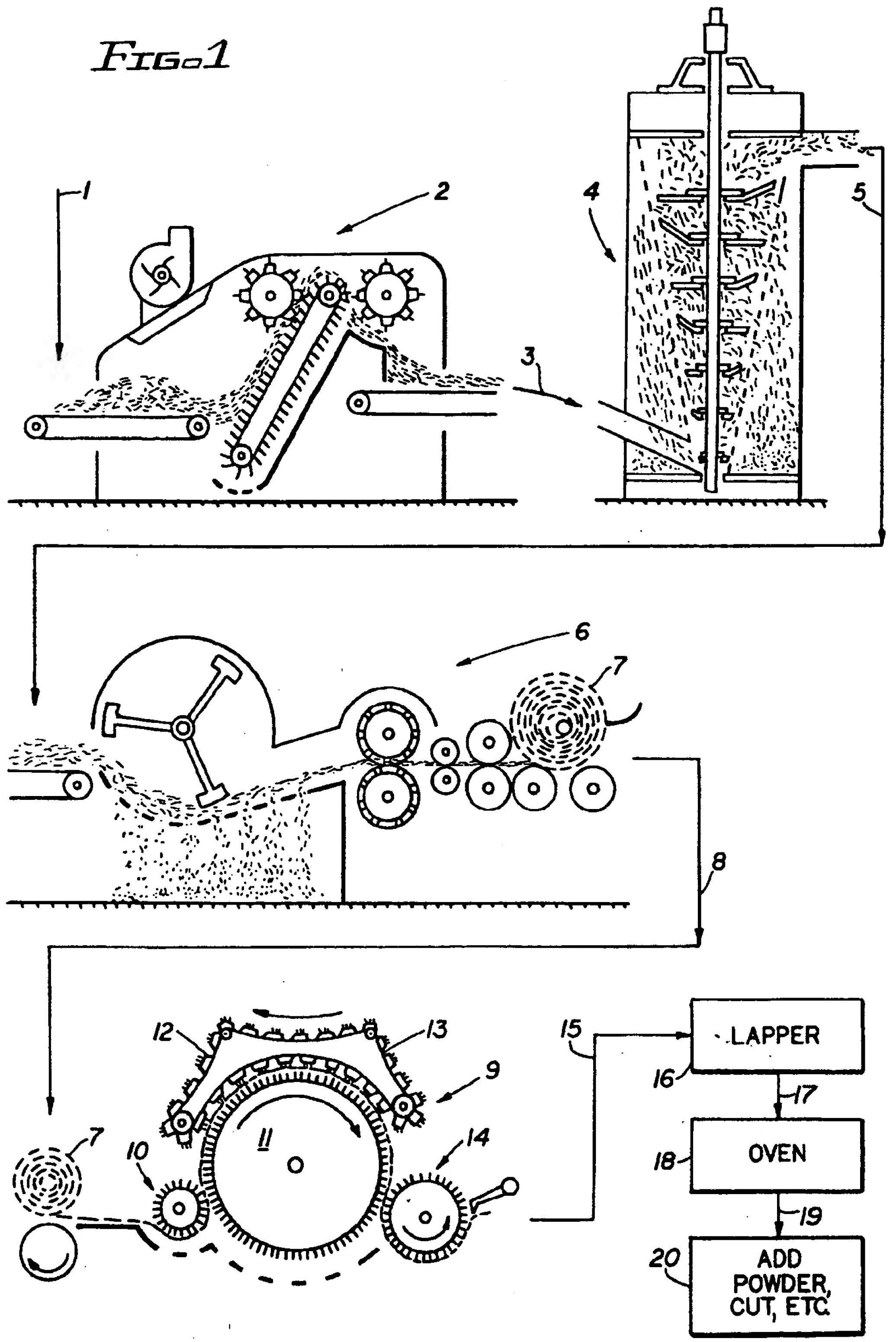
at least certain of said stilt fibers extend from and interconnect insulative fibers in said one of said layers to insulative fibers in said another of said layers, and said stilt fibers maintain a spacing between said one of said layers and said another of said layers and,

(i) cooling said batt to harden said softened binder fibers.

7. The method of Claim 6 wherein said insulative fibers are cotton.

8. The method of Claim 6 wherein said cooled batt has density of less than 1 pound per cubic foot.

FIG. 1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LAPPER
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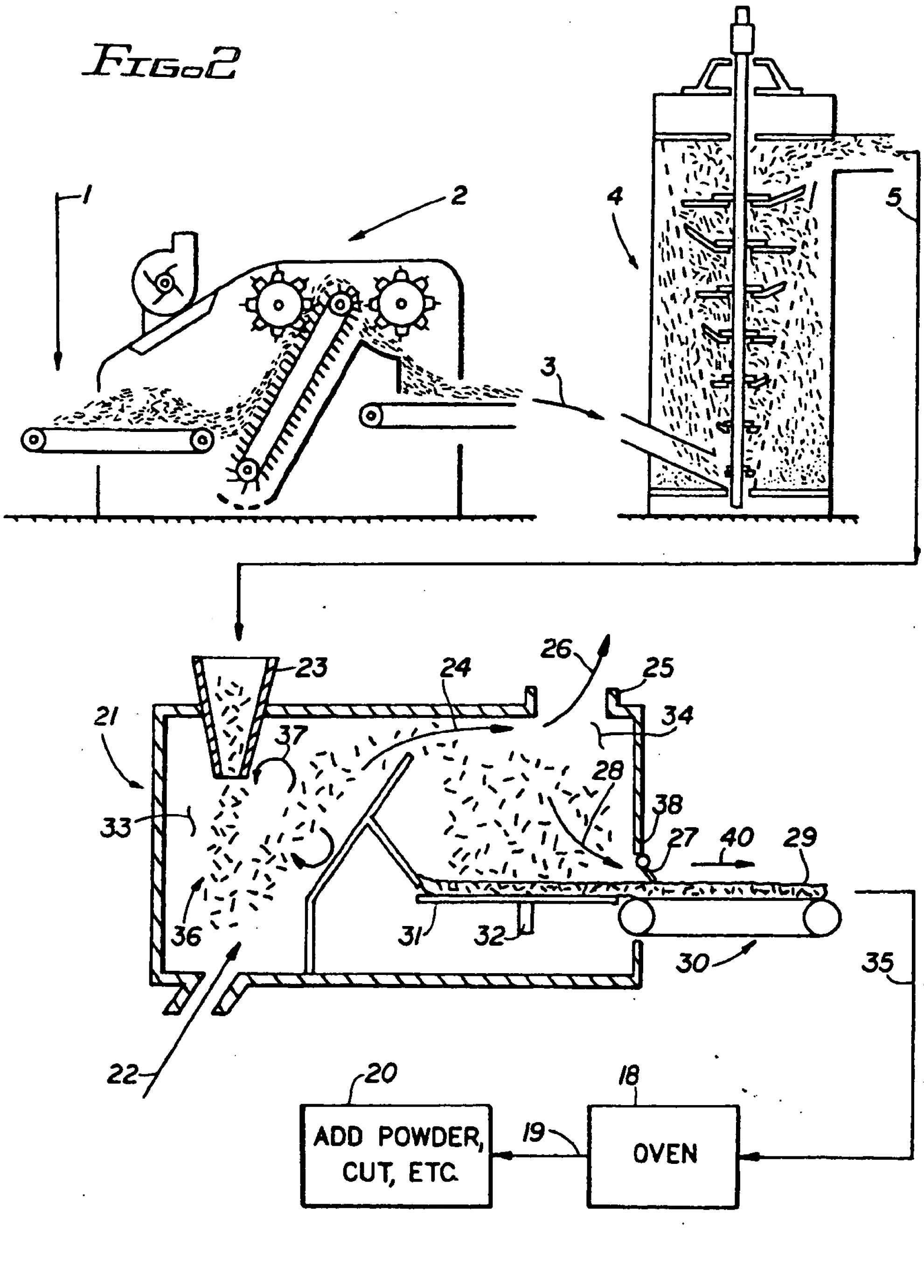
ADD POWDER, CUT, ETC.

FIG. 2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ADD POWDER, CUT, ETC.
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OVEN

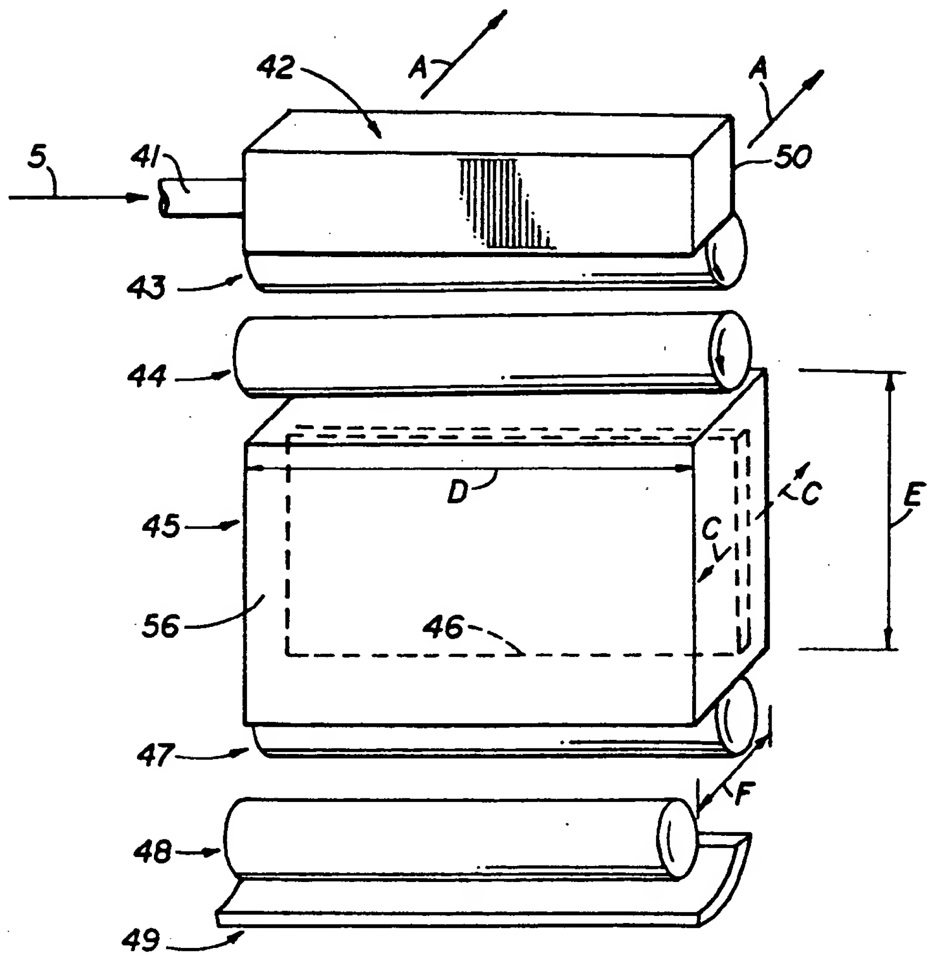

FIG. 3

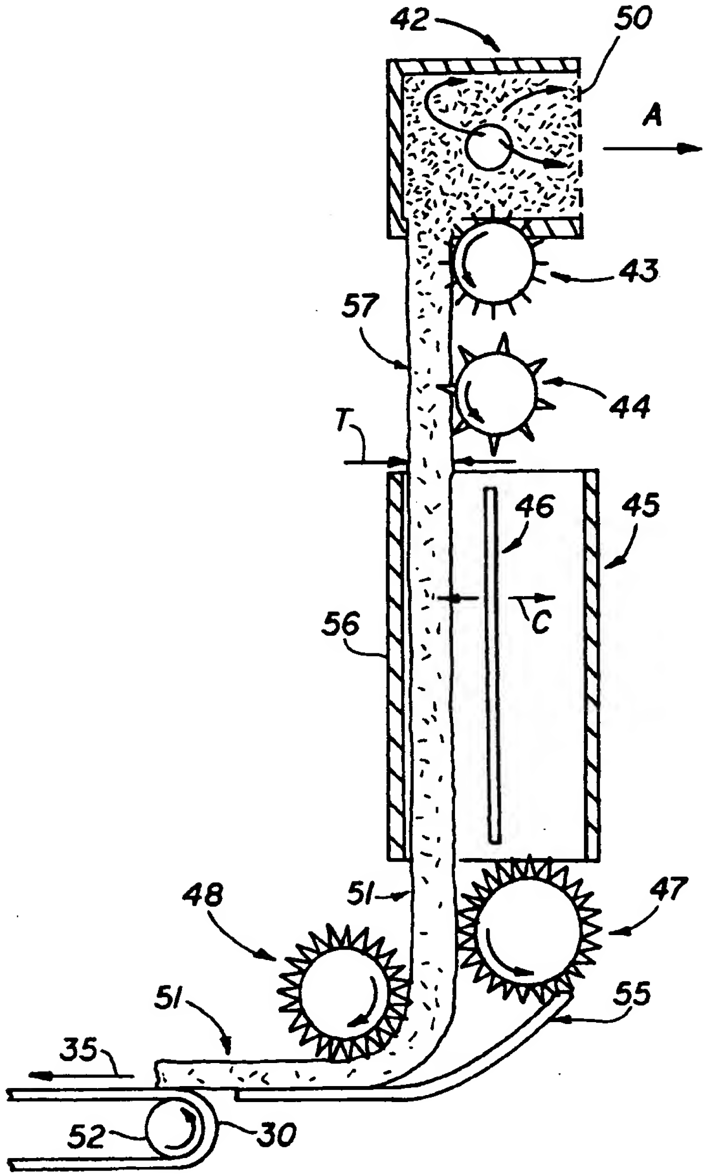

FIG. 4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 10 9995

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	GB-A-2 222 801 (CHING-LONG CHEN) * the whole document * ---	1	D04H1/54 D04H1/42
Y A	FR-A-1 555 796 (G.A.M.M.A.) resume 10-230 * page 1 - page 3; figures 1-5 * ---	1 6,7	
Y	GB-A-618 178 (BRITISH CELANESE) * the whole document * ---	1	
A	EP-A-0 401 738 (E. I. DUPONT) * claims * ---	1,7	
A	GB-A-2 140 837 (ALLEN) * claims 1-16 * ---	1,2,6	
A	GB-A-1 601 170 (JOHNSON & JOHNSON) * claims 1-14 * ---	1,2,6,7	
A	WO-A-8 203 359 (VAN DRESSER) * claims 1-20; figure 4 * ---	1	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A,D	US-A-4 678 822 (RICHARD L. LEWELLIN) * claims 1-12 * ---	1,6	D04H
A	GB-A-1 091 080 (REX ASBESTWERKE) ---		
A	DE-A-3 617 862 (CORD) -----		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	07 OCTOBER 1992	DURAND F.C.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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